Pesticide Use Reporting and Monitoring for Modeling Potential Exposure to Agricultural Pesticides

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Background

- Wisconsin is building a model to assess which drinking water sources may have the potential for exposing populations to agricultural pesticides (Figure 1)
- The State does not have a site based pesticide registry, so they modeled pesticide application at the county level
  - Projected the pounds of pesticide used on crops at the State level on the percentage of the State's crop acreage at the county level to estimate the pounds of pesticide applied at the county level
  - Others have undertaken this task (Figure 2)
- The model assumes a single, uniform pesticide application rate across crop acreage
- Wisconsin wanted to determine if the assumption is valid
  - Empirically test the rate and method with actual, site based pesticide registry data
  - California tracks these site based data in their Pesticide Use Report

Is there a single, stable pesticide application rate?

- Data from the 2003 California Pesticide Use Report were tested for correlations between acres of crop treated and pounds of chemical used for 15 chemicals of concern
- Results were generally poor (Table 1)
- Further scatter plot analysis showed multiple pesticide application rates exist for the pesticides of concern (Figure 3)
  - Some likely influences
    - The effective rate of pesticide application differs for different soil types
    - The necessary application needed for management differs for different pests of concern
  - These influences would be difficult to include in the model

Still, does the application rate stabilize at County scales?

- Projected California's statewide pounds of applied pesticide on their countywide crop acreage
  - Unfortunately, the crop acreage listed as sites in the California Pesticide Use Report Data can't be aggregated to the county scale
    - There could be multiple applications to the same field
    - There could be different crops grown on the same field during the year
  - Obtained the 2002 Census of Agriculture From the U.S. Department of Agriculture's National Agricultural Statistics Service to get California's acreage of individual crops by county and the entire state
  - Associated crops in the Census with crops in the Pesticide Use Report
  - Used the Census data to derive the state's percentage of each associated crop in each county
  - Multiplied each crop's actual pesticide applied in the state from the Pesticide Use Report Data by the crop's percentage in each county
  - Summed the resulting estimated pounds of pesticide applied on each crop in each county to estimate the total pesticide applied in each county
- Assumptions
  - 2002 and 2003 crop acreage and pesticide application totals were the same at the county scale
  - Crop categories in the Pesticide Use Report and the Census were perfectly associated
- Compared the projected pesticide pounds applied with the actual pesticide pounds applied as aggregated by county from the Pesticide Use Report
- Estimates may be off by as many as four orders of magnitude in some counties for some pesticides (Figure 4)

Conclusions

- Pesticide application rates lack stability for simple pesticide application projection based on crop acreage
- Effective pesticide registry information systems would be very helpful in determining the actual application rates in smaller areas

Special thanks to the partners in the Memorandum of Understanding between CDC and EPA for their support in this collaborative project. The views and opinions expressed in this poster are solely those of the authors and are not intended to represent the views and opinions of the CDC, EPA, or the Wisconsin Department of Health and Family Services.

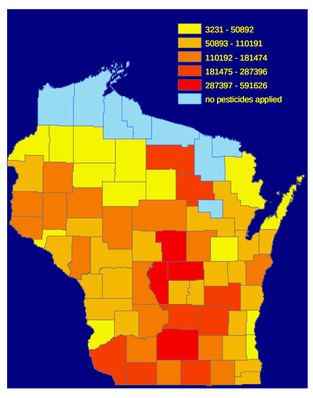


Figure 1
Left: Wisconsin Department of Health and Family Services' County-level Estimates of Total Annual Pesticide Usage in Pounds. ***Right:*** This pesticide application layer, as well as groundwater susceptibility estimates, were used to build a screening-level model to predict each county's population based relative risk for potential pesticide exposure from groundwater and drinking water sources.

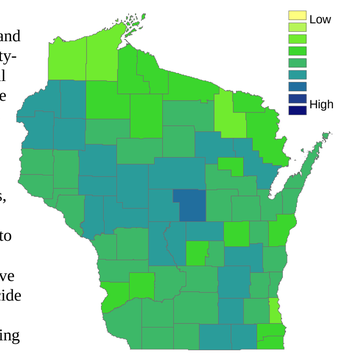
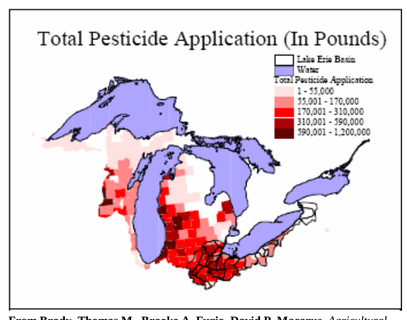


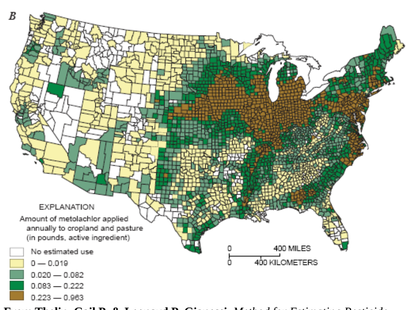
Figure 2 ***Below, left to right***:
Brody, Furio, and Macarus estimated agricultural pesticide use in the Great Lakes Basin for 1994-1995 by projecting pounds of pesticide used on crops at the State level on the percent of crop acreage at the county level.

Thelin and Gianessi used a similar method with more complete 1997 crop data for a national assessment.

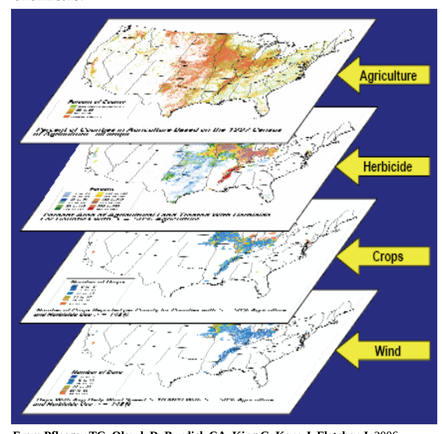
Pfleeger, et al. demonstrated how the Thelin and Gianessi model could be integrated in Geographic Information Systems to locate areas and/or species at risk from potential off target movement of agricultural chemicals.



From Brody, Thomas M., Brooke A. Furio, David P. Macarus. *Agricultural Pesticide Use In The Great Lakes Basin: Estimates of Major Active Ingredients Applied During 1994-1995 For The Lake Erie, Michigan, and Superior Basins*, United States Environmental Protection Agency Region 5, June 15, 1998. <http://www.epa.gov/RCRIS-Region-5/ptb/pest/documents/pest_use.pdf>



From Thelin, Gail.P. & Leonard.P. Gianessi. *Method for Estimating Pesticide Use for County Areas of the Conterminous United States*, U.S. Geological Survey Open-File Report 00-250, 2000. <http://ca.water.usgs.gov/pnsp/rep/ofr00250/ofr00250.pdf>.



From Pfleeger TG, Olszyk D, Burdick CA, King G, Kern J, Fletcher J. 2006. *Using a Geographical Information System to Identify Areas with Potential for Off-Target Pesticide Exposure*. Environmental Toxicology and Chemistry. 25:8 in press.

Chemical Name	N	Pearson
ALACHLOR	424	0.963
BROMOXYNIL BUTYRATE	2	N/A
BROMOXYNIL HEPTANOATE	2925	0.497
BROMOXYNIL OCTANOATE	4202	0.535
CYANAZINE	3	1
DIMETHOATE	23683	0.001
LINURON	2648	0.771
MANEB	40200	-0.020
METAM-SODIUM	4488	0.650
METOLACHLOR	152	0.922
PENDIMETHALIN	9790	-0.011
PIPERONYL BUTOXIDE	38072	0.030
PYRETHRINS	44366	0.047
SIMAZINE	19531	0.072
THIOPHANATE-METHYL	14222	-0.008

Table 1
Using data from the California Pesticide Use Report, correlations were assessed between acres treated and pounds of each pesticide used. These correlations were determined for the universe of N crop sites where each pesticide was applied. Poor correlations indicate difficulties assuming a single, uniform rate of application.

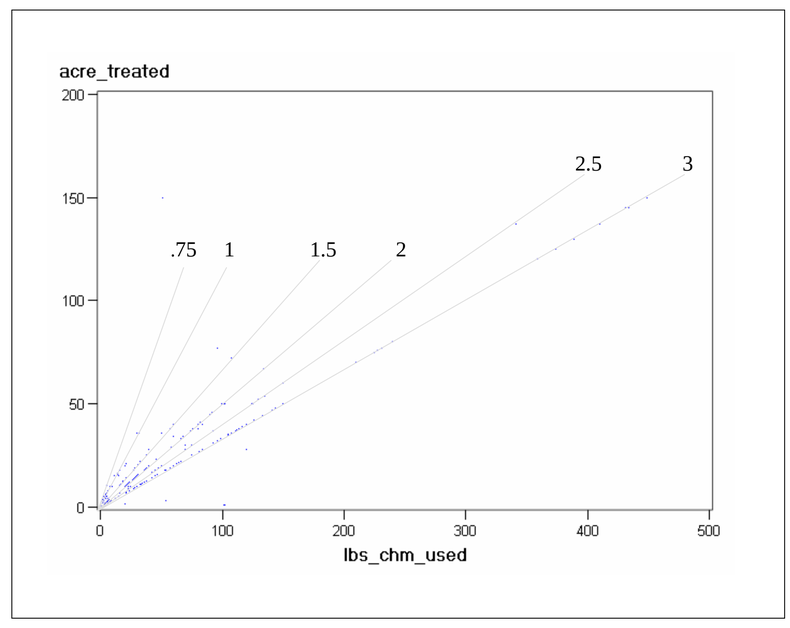


Figure 3
Scatter plot of California's sites where Alachlor was applied (N=424). The results show several distinct rates (pounds/acre) of application, e.g., .75, 1, 1.5, 2, 2.5, and 3. Some likely influences include the effective rate of pesticide application on different crops, pests of concern, and soil types.

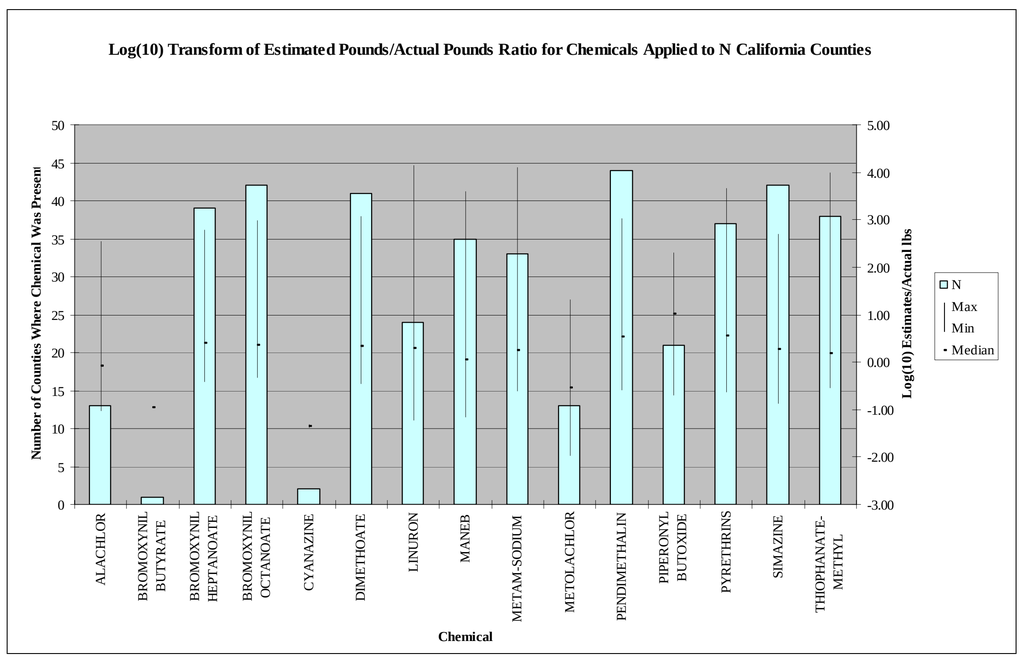


Figure 4
For each county, the estimated pounds were divided by actual pounds. A $\log_{10}$ transform was used to show equal ratio distribution around 0 (a perfect match). Although the actual pounds are within an order of magnitude of the estimate for the median county in most cases, the results show the ratio can be off by over four orders of magnitude for some counties. In other words, the estimates were 10,000 times greater than the actual pesticide applied in some counties. Conversely, some counties had nearly 100 times the actual pesticide applied than were estimated.